Space Storable Hybrid Rockets for Orbit Insertion or In Situ Resource Utilization Applications

Completed Technology Project (2013 - 2016)

Project Introduction

This research effort will pave the way towards a Mars Sample Return (MSR) campaign and potentially, future human exploration of Mars. Hybrid rockets utilize a solid fuel and liquid (or gaseous) oxidizer. A typical flight like configuration is shown in Figure 1. For the MSR application, a hybrid Mars Ascent Vehicle (MAV) would allow the fuel to be transported to Mars as a dense, solid. The oxidizer could be generated from CO2 on the surface, reducing the required landed mass on Mars. Alternatively, a JPL study has recently identified hybrid propulsion as the lowest mass option of two potential technologies that could enable a single stage to orbit MAV.

Goals:
1. Continue development of a flexible facility capable of small scale hybrid propulsion tests. The facility will be able to adapt to new research objectives as questions arise.
2. Enable the inclusion of hybrid propulsion systems in future mission design studies by determining the empirical constants in the regression rate equation for paraffin-based fuels with in situ oxidizers (a combination of O2, CO and CO2).
3. Determine hybrid rocket packaging constraints by testing at different fuel grain L/D's to understand how the combustion efficiency and mixing changes with length.

Anticipated Benefits

For MSR, a hybrid Mars Ascent Vehicle (MAV) would allow the fuel to be transported to Mars as a dense, solid. The oxidizer could be generated from CO2 on the surface, reducing the required landed mass on Mars.

Any mission needing a chemical propulsive capability that requires a restart capability or in-situ oxidizer production.

Of potential utility for commercial missions needing a chemical propulsive capability that requires a restart capability.

Of potential utility for D0D-based missions needing a chemical propulsive capability that requires a restart capability or in-situ oxidizer production.

Space Storable Hybrid Rockets for Orbit Insertion or In Situ Resource Utilization Applications

Table of Contents

Organizational Responsibility

Responsible Mission Directorate:

Mission Support Directorate (MSD)

Lead Center / Facility:

Jet Propulsion Laboratory (JPL)

Responsible Program:

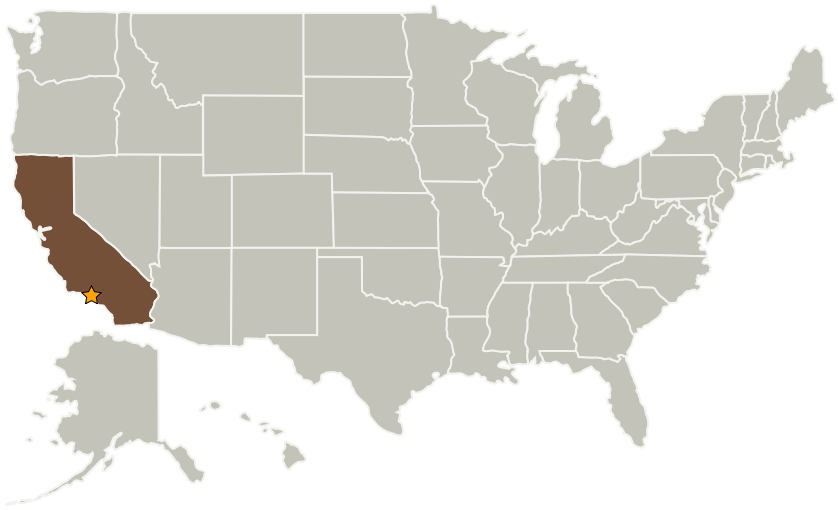
Center Independent Research & Development: JPL IRAD

Center Independent Research & Development: JPL IRAD

Space Storable Hybrid Rockets for Orbit Insertion or In Situ Resource Utilization Applications

Completed Technology Project (2013 - 2016)

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Jet Propulsion Laboratory(JPL)	Lead Organization	NASA Center	Pasadena, California

Primary U.S. Work Locations
California

Project Management

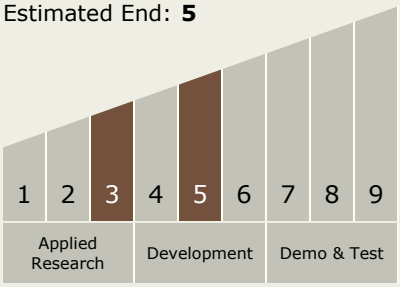
Program Manager:
Fred Y Hadaegh

Project Manager:
Jonas Zmuidzinas

Principal Investigator:
Ashley C Karp

Technology Maturity (TRL)

Start: **3**
Estimated End: **5**



Technology Areas

Primary:

- TX01 Propulsion Systems
  - TX01.1 Chemical Space Propulsion
    - TX01.1.5 Hybrids